

SPORTS-RELATED CONCUSSIONS IN YOUTH:  
IMPROVING THE SCIENCE, CHANGING THE CULTURE

Statement of

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## **Summary of Dr. Robert Graham's Testimony on the Institute of Medicine-National Research Council report on Sports-Related Concussions in Youth**

Much remains unknown about the extent of sports-related concussions in youth; how to diagnose, manage, and prevent concussions; and their short- and long-term health consequences. The Institute of Medicine-National Research Council report *Sports-Related Concussions in Youth: Improving the Science, Changing the Culture* offers the following recommends to help close these information gaps:

- The establishment of a national surveillance system to accurately determine the incidence of sports-related concussions, including in elementary school through college-age youth;
- Research to (1) establish metrics and markers of concussion diagnosis, prognosis, and recovery in youth and (2) inform the creation of age-specific, evidence-based guidelines for concussion management;
- Large-scale longitudinal studies to assess the short- and long-term consequences of concussions, as well as subconcussive impacts (i.e., impacts that do not result in symptoms of concussion), across the life span;
- Scientific evaluation of the effectiveness of age-appropriate techniques, rules, and playing and practice standards in reducing sports-related concussions;
- Research on age- and sex-related biomechanical determinants of risk for concussion in youth;
- Development, implementation, and evaluation of large-scale efforts to increase knowledge about concussions and change the culture surrounding concussions among elementary school through college-aged youth and their parents, coaches, sports officials, educators, trainers, and health care professionals.

Good morning, Mr. Chairman, ranking member Schakowsky, and members of the Subcommittee. My name is Robert Graham. I am Director of the Aligning Forces for Quality program at The George Washington University and served as chair of the Committee on Sports-Related Concussions in Youth (henceforth referred to as “the Committee”) of the Institute of Medicine (IOM) and National Research Council (NRC). The NRC is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the IOM of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology. To carry out the study on sports-related concussions in youth, the IOM-NRC received support from the Centers for Disease Control and Prevention (CDC), the CDC Foundation with support from the National Football League, the Department of Defense (DoD), the Department of Education, the Health Resources and Services Administration, the National Athletic Trainers’ Association Research and Education Foundation, and the National Institutes of Health (NIH).

The Committee was asked to review the available evidence on concussions in youth, including in military personnel and their dependents, related to the causes and consequences of concussions; the current state of the art on concussion diagnosis and management; and the effectiveness of protective equipment and sports regulations for the prevention of concussions. Based on its review of the evidence, the Committee was asked to recommend actions that can be taken by research funding agencies, schools, military organizations, and other stakeholders to improve what is known about concussions in youth, improve their diagnosis and management, and to reduce their occurrence. I am here today to present to you the findings, conclusions, and

recommendations from the Committee's report, *Sports Related Concussions in Youth: Improving the Science, Changing the Culture*, released on October 30, 2013.

## **Surveillance**

Surveillance data can provide valuable information on the incidence and causes of sports-related concussions. Ongoing systems, such as the National Electronic Injury Surveillance System (NEISS), the High School RIO<sup>TM</sup> (Reporting Information Online), and the National Collegiate Athletic Association (NCAA) Injury Surveillance System, are important sources of sports-related injury data, including data on concussions, in youth athletes. However, because these systems were designed to collect data on specific populations they are not able to provide a comprehensive picture of the incidence of concussions across all youth and sports. The NEISS captures data for youth seen in emergency departments, but many concussions are evaluated by athletic trainers, physicians, and other qualified personnel in other venues. Concussion incidence data for high school and college students are captured by the High School RIO<sup>TM</sup> and NCAA Injury Surveillance System, respectively, but these systems were not designed to capture data for the many youth who participate in club sports and competitive and recreational sports outside of an academic setting. In addition, there has been little research on the frequency of concussions in athletes younger than high school age.

Part of the Committee's charge was to examine sports-related concussions among military dependents as well as concussions in military personnel ages 18 to 21 resulting from sports and physical training at military service academies and during recruit training. There is very little data pertaining to this type of injury among the populations specified. With respect to the dependents of military personnel, the Committee found no

evidence that the risks for concussion are different for these youth than for youth in general. With respect to military training, although the committee read anecdotal reports that many military personnel sustain concussions during hand-to-hand (combatives) courses during basic training, data on the occurrence of concussions during such training have not been published in the peer-reviewed literature.

To help close these gaps in sports-related concussion surveillance data, the Committee recommends that the CDC, taking into account existing surveillance systems and relevant federal data collection efforts, establish and oversee a national surveillance system to accurately determine the incidence of sports-related concussions, including in elementary school through college-age youth. Data collected should include demographic information, preexisting conditions (e.g., learning disabilities), concussion history, the use of protective equipment and impact monitoring devices, the qualifications of personnel making the concussion diagnosis, and information on the cause, nature, and extent of injury (Recommendation 1 of the IOM-NRC Report).

The High School RIO<sup>TM</sup> and NCAA Injury Surveillance System have demonstrated some patterns in rates of sports-related concussions among high school and college athletes. In particular, among these athletes concussion rates appear to be higher in competition than in practice (except in cheerleading) and higher among females than males in comparable sports (e.g., basketball, ice hockey, soccer, softball/baseball). Among male athletes at the high school and college levels, football, ice hockey, lacrosse, wrestling, and soccer are associated with higher rates of concussions. Among female athletes, the high school and college sports associated with higher rates of concussions are soccer, lacrosse, basketball, and ice hockey.

## **Diagnosis, Management, and Health Effects**

Given the absence of a diagnostic test or biomarker for concussion, the current cornerstone for concussion diagnosis is confirming the presence of a constellation of concussion signs and self-reported physical-, cognitive-, emotional-, and sleep-related symptoms. Reliance on an athlete's self-report of symptoms to diagnose concussion is complicated by the subjective nature of the assessment and the possibility of an athlete underreporting his or her symptoms. In a 2012 survey of high school football players, for example, a majority indicated that it was "okay" to play with a concussion and said that they would "play through an injury to win a game," despite being knowledgeable about the symptoms and dangers of concussions (Anderson et al., 2013). Combining symptom assessment with other evaluation tools, such as balance testing and neurocognitive assessment, may improve the accuracy of a concussion diagnosis. This is the current preferred method of diagnosing a concussion but the Committee found that existing research is insufficient to determine the best combination of measures.

Neuropsychological tests are designed to detect subtle changes in cognitive function following head injury and are one of several tools used by health care providers to document and track recovery and to help determine when a concussed athlete has recovered enough to return to activity. Yet, the Committee found that studies of the effectiveness of neuropsychological tests to predict diagnosis and track recovery in individuals who have sustained sports-related concussions have had mixed results, and an individual's test performance can be influenced by many factors, including effort and the presence of concussion symptoms (e.g., fatigue resulting from sleep disturbance). The Committee found no data on the effectiveness of neuropsychological testing for

monitoring recovery in individuals whose symptoms persist beyond the typical recovery period of 2 to 3 weeks (i.e., individuals with post-concussion syndrome).

Expert consensus opinion holds that athletes who have sustained a concussion should refrain from physical activity until symptoms have resolved, as activity may worsen symptoms, potentially prolong recovery, and increase risk of a repeat injury (Giza et al., 2013; Halstead et al., 2010; Harmon et al., 2013; McCrory et al., 2013). Mental rest (e.g., eliminating or decreasing activities that require concentration, such as schoolwork) may also be recommended for the initial period following concussion. Although it is widely accepted that concussion symptoms are aggravated by both physical and mental exertion, the Committee found that there is currently little empirical evidence for the optimal degree and duration of rest needed to promote recovery or the best timing and approach for returning to full physical activity.

To improve the science on concussion diagnosis and management, the Committee recommends that the NIH and DoD support research to (1) establish metrics and markers of concussion diagnosis, prognosis, and recovery in youth and (2) inform the creation of age-specific, evidence-based guidelines for concussion management (Recommendation 2 of the IOM-NRC Report).

The Committee found that most studies of the shorter-term effects of multiple concussions show that these injuries result in a decrease in cognitive function, with the most commonly reported neuropsychological impairments being in the areas of memory and processing speed. Studies of the effects of subconcussive impacts (i.e., those that do not result in symptoms of concussion) have had mixed results, with some showing an association between such impacts and functional impairment, and others not. Preliminary advanced imaging research indicates structural changes in the brain

following subconcussive head impacts, but further research is needed to determine whether or not such changes are permanent. The role that multiple concussions and subconcussive impacts play in long-term health also is not fully understood. For example, the Committee found that more data are needed to determine whether multiple concussive or subconcussive impacts sustained in youth increases the risk for later neurodegenerative diseases, such as chronic traumatic encephalopathy—commonly known as CTE—Alzheimer’s disease, or other neurodegenerative diseases. To this end, the Committee recommends that NIH and DoD conduct large-scale longitudinal studies to assess the short- and long-term consequences of concussions, as well as subconcussive impacts, across the life span. Such research should aim to identify predictors and modifiers of negative outcomes, such as sex and comorbidities (e.g., history of substance abuse), among others (Recommendation 3 of the IOM-NRC Report).

### **Safety Standards and Protective Equipment**

Rules of play are the foundation of safe conduct in sports because they set expectations for behavior and define infractions. Although additional research is needed, some research involving youth athletes (e.g., youth ice hockey players) has shown that the enforcement of rules and fair play policies contributes to reductions in the incidence of sports-related injuries, including concussions. In response to concerns about the potential long-term consequences of repetitive head impacts, some youth sports organizations (such as Pop Warner) have called for a “hit count” limiting the amount of head contacts a player can be exposed to over a given period of time. While the concept of limiting the number of head impacts is fundamentally sound, there is currently a lack of evidence to support the use of a specific threshold for the number or magnitude of



impacts a youth athlete is exposed to per week or per season. The committee recommends that the NCAA, in conjunction with the National Federation of State High School Associations (NFHS), national governing bodies for youth sports, and youth sport organizations undertake a scientific evaluation of the effectiveness of age-appropriate techniques, rules, and playing and practice standards in reducing sports-related concussions. DoD should conduct equivalent research for sports and physical training—including combatives—at military service academies and for military personnel (Recommendation 4 of the IOM-NRC Report).

Designing more effective protective equipment may offer one route to protecting youth athletes from concussions. Protective devices reduce the risk for sports-related injuries, such as skull fractures (helmets) and injuries to the eyes, face, mouth, and teeth, and their use should be promoted for this reason. However, the Committee found little evidence that current helmet designs reduce risk of concussions in youth and no evidence that other protective devices (e.g., mouthguards, facial protection worn in ice hockey) reduce concussion risk. In sports, the vast majority of impacts to the head result in a combination of linear (i.e., along a straight line) and rotational acceleration. It is this combination that can lead to a concussion. Current testing standards and rating systems for protective equipment do not incorporate measures of rotational head acceleration or velocity and therefore do not comprehensively evaluate a particular device's ability to mitigate concussion risk. Furthermore, research on the ability of helmets to reduce concussion risk has been conducted predominately in college-age and older individuals and has not taken into account how risk of injury may be modified by sex or prior head injury. The Committee recommends that NIH and DoD fund research on age- and sex-related biomechanical determinants of risk for concussion in youth, including how injury

thresholds are modified by the number previous (concussive and subconcussive) injuries and the time interval between injuries (Recommendation 5 of the IOM-NRC Report).

## **Culture Change**

The acknowledgment of the seriousness of sports-related concussions has initiated a culture change, as evidenced by campaigns to educate athletes, coaches, physicians, and parents of young athletes about concussion recognition and management, rule changes designed to reduce the risk of head injury, and the enactment of legislation designed to protect young athletes suspected of having a concussion. Yet, as the Committee did its research and listened to public testimony, we found indications that the culture shift is not complete. In many settings, the seriousness of the threat to the health of an athlete, both acute and long-term, from suffering a concussion is not fully appreciated or acted upon by athletes, their teammates, and, in some cases, coaches and parents. Similarly, military recruits are immersed in a culture that includes devotion to duty and service before self, and the critical nature of concussions may often go unheeded. If the youth sports community can adopt the belief that concussions are serious injuries and emphasize care for players with concussions until they are fully recovered, then the culture in which these athletes perform and compete will become much safer. The Committee recommends that the NCAA and the NFHS, in conjunction with various other public and private groups, develop, implement, and evaluate the effectiveness of large-scale efforts to increase knowledge about concussions and change the culture—social norms, attitudes, and behaviors—surrounding concussions among elementary school through college-aged youth and their parents, coaches, sports officials, educators, trainers, and health care professionals (Recommendation 6 of the IOM-NRC Report).

Thank you for the invitation to testify. I am happy to answer any questions the Subcommittee might have.

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